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SUITE 1500
50 SOUTH SIXTH STREET
MINNEAPOLIS, MINNESOTA 55402-1498
TELEPHONE: (612) 340-2600
FAX: (612) 340-2868
www.dorseylaw.com

ROBERT E. CATTANACH
Partner
(612) 340-2873
FAX (612) 340-8800
cattanach.robert@dorseylaw.com

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November 8, 2001

Mary T. McAuliffe, Esq.
Environmental Protection Agency Region 5
77 West Jackson Boulevard
Chicago, Illinois 60604-3507

Re: Metropolitan Council Supplemental Environmental Project

Dear Mary:

The enclosed memo from Jon Sandstedt provides the "real world" validation that EPA should find helpful when examining Met Council's analysis of the performance of the control technology without the addition of a dry ESP or fabric filters. As you will see, John has established that: (1) a BACT determination for another fluidized bed incinerator (FBI) required only a wet scrubber followed by a wet ESP in order to meet BACT emission limits comparable to those imposed on the FBIs at the Metro Plant; (2) an independent survey of FBI emission performance confirms that facilities equipped with wet scrubbers and wet ESP control trains consistently attain emission levels that would comply with the Metro Plant permit limits. John also goes on to summarize the analysis establishing that compliance can be achieved using a wet scrubber/wet ESP control train, using AP-42 with conservative assumptions, to confirm that compliance would not require a dry ESP or fabric filters.

We trust that this is the type of validation of the AP-42 analysis that EPA was looking for, and that this confirms that no technical or legal basis exists to challenge the proposed modification of the SEP. If you have any questions, please let me know. As in the past, we would have no objection if Erik wanted to speak with John directly if there are any remaining

DORSEY & WHITNEY LLP

Mary McAuliffe
November 8, 2001
Page 2

points that need further clarification. We sincerely appreciate your cooperation in this regard, and hope that we can move forward with what all objective minds have agreed is a desirable improvement to the SEP.

Sincerely,

A handwritten signature in black ink, appearing to read 'R. Cattnach', with a large, stylized initial 'R'.

Robert E. Cattnach

Attachment

cc: Mark Thompson, Esq.
Randall Stone, Esq.
Rebecca Flood
William Moore
Erik Hardin

**Compliance with Particulate Emission Limits
Metropolitan Wastewater Treatment Plant
Fluidized Bed Incinerators
November 9, 2001
Prepared by Earth Tech, Inc.**

Four separate analyses confirm that the fluidized bed incinerators (FBIs) to be constructed at the Metropolitan Wastewater Treatment Plant (Metro Plant) would achieve compliance with the emission limits specified in its MPCA air emissions permit even without the installation of a dry electrostatic precipitator (ESP) or fabric filter baghouse. Sufficient control is provided by the venturi scrubber and wet ESP to achieve compliance with the permit limits for total particulate matter (PM), PM₁₀, and lead. Therefore, the installation of a dry ESP or fabric filter baghouse qualifies as a Supplemental Environmental Project.

The following analyses were performed:

1. An independent survey of FBI emission performance conducted by the Metropolitan Council's design consultant confirms that FBIs equipped with wet scrubber/wet ESP air pollution control trains consistently achieve emission concentrations that would comply with the Metro Plant permit limits.
2. A search of EPA's RACT/BACT/LAER Clearinghouse data base shows that a Best Available Control Technology (BACT) determination for a FBI at another wastewater treatment plant has required installation of a two-stage air pollution control system consisting of a wet scrubber followed by a wet ESP. The BACT emission limits for this unit are comparable to the limits imposed on the FBIs at the Metro Plant.
3. Information published in EPA's AP-42 emission factor guidance regarding particulate size distribution and air pollution control efficiencies were applied to site-specific measurements of the potential uncontrolled emissions, which were conservatively assumed to be equal to the inert solids in the sewage sludge.
4. AP-42 controlled emission factors, expressed in lb of emission per dry ton of sludge charged, confirm that compliance is achievable.

Each of these analyses is explained further in the following sections.

Independent Survey of FBI Performance

Performance tests conducted on FBI installations similar to those planned for the Metro Plant indicate that the emission limits can be met using only a wet venturi scrubber and a wet ESP. CH2MHill, the design contractor for this project, provided performance test data obtained for three other incinerators that are similar in design to those planned for the Metro Plant. These data are included in Exhibit A. CH2MHill provided information on four other facilities. Each of these facilities is equipped with a venturi scrubber/tray tower and a wet ESP. Performance tests from these facilities show that particulate emissions are well below the Metro Plant's PM permit limit.

	PM Concentration (gr/dscf)
Metro Plant FBI Permit Limit	0.017 (concentration equivalent to permit limit)
Bayshore Regional Sewerage Authority – test result	0.00025
North West Bergen County Utilities Authority – test result	0.002
Pfizer, Inc., U.S. Pharmaceuticals – test result	0.0016
Pequannock, Lincoln Park, & Fairfield Sewerage Authority – test result	0.0031

Note: MCES concentration numbers are equivalent to the permitted limits.

RACT/BACT/LAER Clearinghouse

A search of the RBLC database for sewage sludge incinerators indicates the MCES Metro plant will be able to achieve its emissions limits without the use of a dry ESP or a fabric filter. The results of this search are included in Exhibit B. The search showed one PSD applicable unit with a similar configuration to the MCES Metro incinerators. RBLC ID# CT-0132, is a fluidized bed sewage sludge incinerator located in Waterbury, Connecticut. This incinerator is equipped with a venturi tray tower scrubber and a wet electrostatic precipitator. This combination of control equipment results in a PM limit of 0.015 gr/dscf @ 7% O₂, and a control efficiency of 99.9%. The PM emission limit for the MCES Metro plant is 0.736 lb/Dt sludge, which is equivalent to an exhaust concentration of 0.017 gr/dscf. The calculation for converting from lb/Dt to gr/dscf is shown below. The projected actual PM emissions, with only the venturi scrubber and wet ESP operating, are 0.582 lb/Dt sludge, which is equivalent to a concentration of 0.014 gr/dscf and corresponds to a control efficiency of 99.9%. This data shows that an FBI equipped with only a wet scrubber and a wet ESP will be able to meet the emission limits imposed on the Metro Plant FBIs.

	Controlled Emissions Factor (lb/dry ton sludge charged)	PM Concentration (gr/dscf @ 7% O ₂)
MCES Permit Limit	0.736	0.017
MCES Predicted Actual Emissions	0.582	0.014
RBLC CT-0132 Limit		0.015

Example calculation:

$$0.736 \text{ lb/Dt} \times 4.375 \text{ Dt/hr (design capacity)} \times 1/60 \text{ hours/minute} = 0.0537 \text{ lb/min}$$

$$0.0537 \text{ lb/min} / 16,100 \text{ acfm} = 3.33\text{E-}06 \text{ lb/acf}$$

$$3.33\text{E-}06 \text{ lb/acf} \times 7000 \text{ gr/lb} = 0.023 \text{ gr/acf}$$

$$0.023 \text{ gr/acf} \times (537 \text{ deg R} / 710 \text{ deg R}) = 0.017 \text{ gr/dscf} \quad (\text{temperature correction})$$

Note: Assumes exhaust gas is dry. Actual concentration will be lower due to water content of exhaust.

Control Efficiency Calculations

Estimates of controlled emissions of PM, PM₁₀, and Pb are less than the respective permit limits. A comparison of the estimates of controlled emissions with the permit limits is summarized in the table below. The estimates are based on the assumption that each air pollution control train would consist of a wet scrubber and a wet electrostatic precipitator and that no dry electrostatic precipitator would be installed between the waste heat boiler and the wet scrubber.

Pollutant	Controlled Emissions (lb/dry ton sludge charged)	Permit Limit (lb/dry ton sludge charged)
PM	0.58	0.736
PM ₁₀	0.42	0.434
Lead	0.0019	0.0119

The calculations, underlying assumptions, and data sources are described below and in Exhibit C. It is conservatively assumed that all of the inert materials that are charged to the fluidized bed sewage sludge incinerator will be discharged from the incinerator with the exhaust gases. The inert mass in Metro's sludge charged to the incinerators is approximately 600 lb/Dt, which is assumed to represent the uncontrolled emission factor for the incinerators.

The calculations of maximum controlled emissions for PM, PM₁₀, and lead are based on size-specific control efficiencies for each piece of control equipment. The efficiencies were obtained from AP-42, Appendix B-2, Table B.2-3.

Electrostatic precipitator design parameters can be changed to meet the emission requirements of the specific application. Design variables that can be adjusted include the number of fields, the specific collection area, plate separation distance, and other parameters. The impact of these parameters is described in the *Air Pollution Engineering Manual, Second Edition* (Air & Waste Management Association, John Wiley and Sons, 2000, pages 86-99). AP-42, Appendix B-2, Table B.2-3, specifies efficiencies to be used for low, medium, and high efficiency ESPs. The control efficiencies for this analysis were taken from the entry for "Electrostatic Precipitator – medium efficiency, other".

The particle size distribution for the uncontrolled emissions was obtained from AP-42, Section 2.2, Table 2.2-10, and was applied to the uncontrolled particle emission factor of 600 lb/Dt. The size-specific control efficiency was applied to the inlet emission factor for the dry ESP (for this exercise, the control efficiency is zero), and an outlet emission factor was determined for each size division. This serves as the inlet emission factor for the venturi scrubber. The size-specific control efficiency is applied to this emission factor and distribution. The outlet emission factor from the venturi scrubber then becomes the inlet emission factor for the wet ESP. A final emission factor and overall control efficiency is then determined.

Based on the 600 lb/Dt emission factor and the size specific control efficiencies, the controlled emission factor for PM is 0.58 lb/Dt. The permit limit for PM is 0.736 lb/Dt. The controlled emission factor for PM₁₀ is 0.42 lb/Dt. The permit limit for PM₁₀ is 0.434 lb/Dt.

Lead emissions are calculated in the same manner based on the assumption that the uncontrolled lead emission factor is distributed over the same size range as PM₁₀. The uncontrolled lead emission factor of 0.276 lb/Dt was obtained from 1997 sewage sludge sampling. The controlled emission factor for lead is 0.0019 lb/Dt. The permit limit for lead is 0.0119 lb/Dt.

Published Emission Factors

A comparison of the predicted Metro Plant FBI emissions performance with the emission factors published in AP-42 indicates that the Metro Plant FBIs would be able to meet the emission limits without a dry ESP or fabric filter baghouse. The table below shows a comparison of the emission factors published in AP-42, Fifth Edition, Section 2.2, "Sewage Sludge Incineration", Table 2.2-6, with the Metro Plant FBI permit limit. The AP-42 factor for an FBI equipped with a wet scrubber with wet ESP indicates that controlled emissions are less than the Metro Plant FBI emission limits.

	PM Emissions (lb/dry ton sludge charged)	Pb Emissions (lb/dry ton sludge charged)
Metro Plant FBI Permit Limit	0.736	1.2E-02
AP-42, Venturi/impingement/wet ESP	0.2	2.0E-06

Exhibit A
Contractor Supplied FBI Performance Data

SECTION 1.0 **INTRODUCTION**

Environmental Laboratories Inc. (ELI) was retained by Hankin Environmental Systems Inc. (HES) to perform all the required emission testing for the Pequannock, Lincoln Park and Fairfield Sewerage Authority (PLFSA) located in Lincoln Park, New Jersey. The emission test program was performed to determine compliance with the State of New Jersey's Department of Environmental Protection and Energy (NJDEP) Permit to Operate.

A summary of the testing program used can be found in Table 1-1. A summary of the test program results can be found in Table 1-2. All parameters were below or well below all applicable limits. Please note that in the cases of Hydrogen Chloride (HCl), Cadmium (Cd), Nickel (Ni), and Zinc (Zn), the blank concentrations were used in order to calculate compliance with emission limits. This was done due to the blank concentration being higher than the samples collected, therefore showing the worst case scenario. Table 1-3 shows a summary of actual results obtained for the above mentioned parameters in order to calculate scrubber efficiency. Detailed results of each individual test can be found in Section 4.0 and the appropriate appendices. The incinerator operated at approximately 1.5 dry tons/hr of sludge throughout the test program.

Testing was performed on October 26, 27 and 28, 1994.

ENVIRONMENTAL LABORATORIES INC

SECTION 2.0
DESCRIPTION OF THE FACILITY

Incinerator #2 is a Fluid Bed Municipal Sludge Cake Incinerator located within the Pequannock, Lincoln Park and Fairfield Sewerage Authority's Treatment Plant at the end of Lincoln boulevard, Lincoln Park, New Jersey.

The system is designed to incinerate belt press filter cake from a mixture of chemically conditioned thickened waste sludge, consisting of combined gravity thickened primary and activated secondary sludge of the following specification:

18% to 30% Dry Solids

50% to 75% Volatile Solids

9,500 to 11,500 Btu/lb Combustibles Higher Heating Value

The capacity of the incinerator is 36 dry tons per day. This is based on a sludge specification of:

26% Dry Solids

75% Volatile Solids

9,500 Btu/lb Combustibles Higher Heating Value

The incinerator is designed to exhaust gases at a temperature ranging between 1500 and 1600°F. The incinerator exhaust gases first pass through a heat exchanger to heat incoming sludge combustion air, then through a Venturi Scrubber and Impingement Tray Tower with provision to inject caustic and finally through a Wet Electro Static Precipitator before discharging into the atmosphere via the stack.

Figure 2-1 presents a schematic of the facility's Process Flow.

ENVIRONMENTAL LABORATORIES INC

TABLE 1-2
PEQUANNOCK, LINCOLN PARK & FAIRFIELD SEWERAGE AUTHORITY
SUMMARY OF EMISSION TEST RESULTS
OUTLET

Parameter	Engine Units	Avg. of 3 Runs	Permit Limit
Particulate Matter (PM)	gr/dscf @ 7% O ₂	0.0031	0.015
Particulate Matter (PM)	lb/hr	0.1865	0.75
Sulfur Dioxide (SO ₂)	ppm @ 7% O ₂	32.19	50.0
Sulfur Dioxide (SO ₂)	lb/hr	2.22	3.10
Nitrogen Oxides (NO _x)	lb/hr	0.87	3.84
Nitrogen Oxides (NO _x)	lb/tons DS	0.61	2.53
Carbon Monoxide (CO)	lb/hr	0.01	2.94
Carbon Monoxide (CO)	ppm	0.31	100.0
Volatile Organic Compounds (VOC)	lb/hr	0.02	0.3
Hydrogen Chloride (HCl)	lb/hr	0.012	0.14
2,3,7,8 Tetrachloro-di-benzo dioxin (TCDD)	lb/hr	4.09 E-10	4.32 E-9
Benzo (a) Pyrene	lb/hr	2.15 E-6	6.19 E-4
Arsenic (As)	lb/hr	1.20 E-5 ND	1.5 E-4
Cadmium (Cd)*	lb/hr	4.78 E-5	1.7 E-3
Chromium (Total)	lb/hr	1.16 E-4	8.1 E-3
Nickel (Ni)*	lb/hr	4.85 E-4	3.7 E-2
Beryllium (Be)	lb/hr	1.20 E-6 ND	1.2 E-4
Lead (Pb)	lb/hr	3.10 E-4	0.0033
Mercury (Hg)	lb/hr	7.91 E-3	0.0285
Copper (Cu)	lb/hr	7.58 E-5	—
Selenium (Se)	lb/hr	1.36 E-5	—
Zinc (Zn)*	lb/hr	1.41 E-3	—
Hexavalent Chromium (Cr ⁺⁶)	lb/hr	1.76 E-6	—
Opacity	%	0.48	10
Cyclonic Flow	degrees	0.75	20

Notes: ND - Not detected, represents limit of analytical detection.

* - Blank concentration used instead of sample concentration.

PROJECT REFERENCES

Agency Name - Bayshore Regional Sewerage Authority
Agency Address - 100 Oak Street
Union Beach, NJ 07735

Agency Contact Mr. Gary Marshall

Phone - 908-739-2459

Project Description/DB's Role: IDI was subcontractor to General Contractor, but provided installation.

Scope of supply included reactor, refractory, primary and secondary heat exchangers, pneumatic sand loading and return systems, preheat system, blowers, pumps, venturi scrubber/tray tower, caustic addition system, wet ESP, stack, ductwork, piping, wiring, CEMS, instrumentation, PLC based control system and complete installation and testing.

Years of Operation

From - November 1995 To - Present

Number of FBI Trains - One

Design Dry Solids Feed (US tons/hr) - 1.125

Operating Dry Solids Feed (US tons/hr) - 1.125

Type of Sludge: Primary and Waste Activated Municipal Sludge

Feed Solids Characteristics

Moisture (%) - 77

VSS(%) - 70

FBI Reactor

Wind box Dia. (ft) - 11.0 height (ft) - 6 Temp (°F) - 1200

Sand Bed Dia. (ft) - 14.2 height (ft) - 5 Temp (°F) - 1300

Free Board Dia. (ft) - 17.8 height (ft) - 17 Temp (°F) - 1550

Free Board Residence Time (above expanded sand bed -seconds) - > 7

Bed superficial space velocity (ft/sec) - 3.08

Free Board superficial space velocity (ft/sec) - 1.96

Number of feed points - Two

Description of sand bed support structure - Refractory Arch with 1200°F preheated air

Waste Heat Recovery - No

Steam -

Pressure (psi) -

Manufacturer -

Type -

Turbine Generator - No

Size -

Manufacturer -

Type -

Air Pollution Control Train - Venturi Scrubber/Tray Tower with Caustic Addition and Wet ESP.
Plume suppression by hot air injection

Performance Test Results

Particulate - 0.00025 gr./dscf

CO - 0.4 ppmv

THC - 1.9 ppmv

NOx - 22.1 ppmv

SO2 - 22.2 ppmv

Project References

Agency Name - North West Bergen County Utilities Authority
Agency Address - 30 Wyckoff Avenue, PO Box 225
Waldwick, NJ 07463

Agency Contact Mr. John Myer

Phone - 201-447-2660

Project Description/DB's Role: IDI was prime contractor.

Scope of supply included reactor, refractory, preheat system, primary and secondary heat exchangers, venturi scrubber, wet ESP, pumps, blowers, ductwork, piping, wiring, CEMS, PLC based control system and testing.

Years of Operation

From - December 1999

To - Present

Number of FBI Trains - One

Design Dry Solids Feed (US tons/hr) - 1.1

Operating Dry Solids Feed (US tons/hr) - 1.1

Type of Sludge: Primary and Waste Activated Municipal Sludge

Feed Solids Characteristics

Moisture (%) - 77

VSS(%) - 78

FBI Reactor

Wind box Dia. (ft) - 9.6 height (ft) - 6 Temp (°F) - 1200

Sand Bed Dia. (ft) - 12.75 height (ft) - 5 Temp (°F) - 1300

Free Board Dia. (ft) - 16.0 height (ft) - 16 Temp (°F) - 1550

Free Board Residence Time (above expanded sand bed -seconds) - 7.1

Bed superficial space velocity (ft/sec) - 3.27

Free Board superficial space velocity (ft/sec) - 2.07

Number of feed points - Two

Description of sand bed support structure - Refractory arch with 1200°F preheated air

Waste Heat Recovery - No

Steam -

Pressure (psi) -

Manufacturer -

Type -

Turbine Generator - No

Size -

Manufacturer -

Type -

Air Pollution Control Train - Venturi scrubber/tray tower and wet ESP. Plume suppression by hot air injection

Performance Test Results

Particulate - 0.002 grains/dscf

CO - 9.7ppmv

THC - 4.6ppmv

NOx - 56.8 ppmv

HCl - 0.2 ppmv

SO2 - 0.62 ppmv

Project References

Agency Name - Pfizer, Inc. U.S. Pharmaceuticals
Agency Address - 445 East Point Road
Groton, CT 06340-5197

Agency Contact Mr. Michael Ritz

Phone - 203-441-3374

Project Description/DB's Role: IDI was subcontractor to General Contractor
Scope of supply included reactor, refractory, preheat system, primary heat exchanger, wet scrubber/tray tower, caustic system, wet ESP, ash thickener, vacuum filter, sand and clay addition systems, blowers, pumps, MCC, ducting, instrumentation, CEMS, PLC based control system and testing.

Years of Operation From - September 1995 To - Present
Number of FBj Trains - One Design Dry Solids Feed (US tons/hr) - 0.76
Operating Dry Solids Feed (US tons/hr) -

Type of Sludge: Industrial biosolids, contaminated air

Feed Solids Characteristics

Moisture (%) - 73

VSS(%) - 75.4

FBI Reactor

Wind box Dia. (ft) - 7.7 height (ft) - 6 Temp (°F) - 1200

Sand Bed Dia. (ft) - 10.1 height (ft) - 5 Temp (°F) - 1300

Free Board Dia. (ft) - 12.2 height (ft) - 16 Temp (°F) - 1550

Free Board Residence Time (above expanded sand bed -seconds) - > 7

Bed superficial space velocity (ft/sec) - 3.2

Free Board superficial space velocity (ft/sec) - 2.1

Number of feed points - Two

Description of sand bed support structure - Refractory Arch with 1200°F
preheated air

Waste Heat Recovery - No
Manufacturer -

Steam -
Type -

Pressure. (psi) -

Turbine Generator - No
Manufacturer -

Size -
Type -

Air Pollution Control Train - Wet venturi scrubber/tray tower and wet ESP

Performance Test Results

Particulate - 0.0016 gr./dscf
CO - 0.8 ppmv
NOx - 41 ppmv
THC - 4 ppmv
SO2 - 16 ppmv

Exhibit B
RBLC Search Report

Exhibit B.txt

Report Date: 11/05/2001

Control Technology Determinations (Freeform)

RBLC Id:	CT-0132
*Company:	CITY OF WATERBURY
Address:	199 MUNICIPAL ROAD
City:	WATERBURY
County:	NEW HAVEN
State:	CT
Zip Code:	06708-
EPA Region:	1
Agency Code:	CT001
Agency Name:	CONNECTICUT BUREAU OF AIR MANAGEMENT
Agency Contact:	DAVID LA RIVIERE
Agency Phone:	(860) 424-3028
Agency Email:	
*Permit/File No.:	192-0149
*SIC:	4952
Airs Id:	09-009-7065
EPA Id:	
Plant Contact Name:	DAVID LA RIVIERE
Plant Contact Phone:	(860) 424-3028
Plant Contact Email:	
Fuel:	
Abatement:	
UTM Zone:	
X Coordinate:	
Y coordinate:	
Application Received Date:	07/20/1994 ACT
Permit Issuance Date:	06/15/1995 ACT
Start Up Date:	11/20/1996 ACT
Compliance Validation Date:	05/28/1997 ACT
Entry Date:	06/17/1999
Last Update:	06/17/1999
New or Modified:	
Public Hearing:	
Narrative:	
Notes:	MUNICIPAL SEWAGE TREATMENT PLANT

Report Date: 11/05/2001

Control Technology Determinations (Freeform)

*Process:	INCINERATOR
*Process Type:	21.004
*SCC Code:	5-01-005-16
Primary Fuel:	SEWAGE SLUDGE
Throughput:	2.08
Throughput Unit:	T/H DRY
Compliance Verified:	No
Stack Testing:	No
Inspections:	No
Calculations:	No
Other Testing:	No
Other Testing Method:	
Process/Compliance Notes:	DORR-OLIVER N-4003-F01 FLUIDIZED BED SEWAGE SLUDGE INCINERATOR
*Pollutant:	PM
*CAS Number:	PM
*Control Method Code:	A
*Control Method Description:	VENTURI TRAY TOWER SCRUBBER/WET ELECTRO-STATIC PRECIPITATOR
Number of Options Considered:	2
Rank of Option Selected:	1

Exhibit B.txt
Primary Emissions: .015
Primary Emissions Unit: GR/DSCF @ 7% O2
*Basis: BACT
*Percent Efficiency: 99.9
Alternate Emission: .02
Alternate Emission Unit: LB/MMBTU
Standard Emission: 0
Standard Emission Unit:
*Emission Type: P
CAP Cost of Control Equipment: \$ 1,115,167
Annualized Cost: \$ 380,825
O&M Cost: \$ 163,366
Cost Effectiveness:
Cost Verified by Agency: No
Dollar Year Used In Cost Estimates: 1994

*Pollutant: SOX
*CAS Number: 7446
*Control Method Code: A
*Control Method Description: VENTURI TRAY TOWER SCRUBBER
Number of Options Considered: 2
Rank of Option Selected: 1
Primary Emissions: .29
Primary Emissions Unit: LB/MMBTU
*Basis: BACT
*Percent Efficiency: 80
Alternate Emission: 15.43
Alternate Emission Unit: PPM
Standard Emission: 0
Standard Emission Unit:
*Emission Type: P
CAP Cost of Control Equipment:
Annualized Cost:
O&M Cost:
Cost Effectiveness:
Cost Verified by Agency: No
Dollar Year Used In Cost Estimates:

*Pollutant: NOX
*CAS Number: 10102
*Control Method Code: P
*Control Method Description: COMBUSTION CONTROL
Number of Options Considered: 3
Rank of Option Selected: 2
Primary Emissions: .16
Primary Emissions Unit: LB/MMBTU
*Basis: BACT
*Percent Efficiency: 0
Alternate Emission: 8.33
Alternate Emission Unit: PPM
Standard Emission: 0
Standard Emission Unit:
*Emission Type: P
CAP Cost of Control Equipment:
Annualized Cost:
O&M Cost:
Cost Effectiveness:
Cost Verified by Agency: No
Dollar Year Used In Cost Estimates:

*Pollutant: VOC
*CAS Number: VOC
*Control Method Code: P

	Exhibit B.txt
*Control Method Description:	COMBUSTION CONTROL
Number of Options Considered:	2
Rank of Option Selected:	1
Primary Emissions:	.04
Primary Emissions Unit:	LB/MMBTU
*Basis:	BACT
*Percent Efficiency:	0
Alternate Emission:	2.11
Alternate Emission Unit:	PPM
Standard Emission:	0
Standard Emission Unit:	
*Emission Type:	P
CAP Cost of Control Equipment:	
Annualized Cost:	
O&M Cost:	
Cost Effectiveness:	
Cost Verified by Agency:	No
Dollar Year Used In Cost Estimates:	
*Pollutant:	CO
*CAS Number:	630-08-0
*Control Method Code:	P
*Control Method Description:	COMBUSTION CONTROL
Number of Options Considered:	2
Rank of Option Selected:	1
Primary Emissions:	.07
Primary Emissions Unit:	LB/MMBTU
*Basis:	BACT
*Percent Efficiency:	0
Alternate Emission:	3.7
Alternate Emission Unit:	PPM
Standard Emission:	0
Standard Emission Unit:	
*Emission Type:	P
CAP Cost of Control Equipment:	
Annualized Cost:	
O&M Cost:	
Cost Effectiveness:	
Cost Verified by Agency:	No
Dollar Year Used In Cost Estimates:	

Exhibit C
Control Efficiency Calculations

**Metropolitan Wastewater Treatment Plant
Fluidized Bed Incinerator Emission Rates**

PM

Size Range (μm)	Dry ESP (%)	Venturi Scrubber (%)	Wet ESP - Medium Efficiency (%)	Uncontrolled Mass = (facility sludge inert mass)	600 lb/Dt
6.0-10	0	99	97		
2.5-6	0	95	90		
0-2.5	0	90	80		

Particle size (μm)	Mass % < (%)	Size range (μm)	Mass % in range (%)	Uncontrolled (lb/Dt)	Dry ESP exit (lb/Dt)	Venturi exit (lb/Dt)	Wet ESP exit (lb/Dt)
>15		>15	85	510	510	5.1	0.153
15	15	10 - 15	5	30	30	0.3	0.009
10	10	5 - 10	4.7	28.2	28.2	0.282	0.00846
5	5.3	2.5 - 5	2.5	15	15	0.75	0.075
2.5	2.8	1 - 2.5	1.6	9.6	9.6	0.96	0.192
1	1.2	0.625 - 1	0.45	2.7	2.7	0.27	0.054
< 0.625	0.75	< 0.625	0.75	4.5	4.5	0.45	0.09
Controlled mass rate (lb/Dt) =				600	8.112	0.58146	
Device efficiency =				0.00%	98.65%	92.83%	
Cumulative efficiency =					98.65%	99.90%	

Overall Efficiency = 99.903%

Controlled Emissions = 0.5815 lb PM/Dt

Permit Limit = 0.736 lb PM/Dt (equivalent to permit limit of 3.22 lb/hr, 4.375 Dt/hr feedrate)

PM10

Size Range (μm)	Dry ESP (%)	Venturi Scrubber (%)	Wet ESP - Medium Efficiency (%)	Uncontrolled Mass = (facility sludge inert mass)	60 lb/Dt
6.0-10	0	99	97		
2.5-6	0	95	90		
0-2.5	0	90	80		

Particle size (μm)	Mass % < (%)	Size range (μm)	Mass % in range (%)	Uncontrolled (lb/Dt)	Dry ESP exit (lb/Dt)	Venturi exit (lb/Dt)	Wet ESP exit (lb/Dt)
10	100	5 - 10	47	28.2	28.2	0.282	0.00846
5	53	2.5 - 5	25	15	15	0.75	0.075
2.5	28	1 - 2.5	16	9.6	9.6	0.96	0.192
1	12	0.625 - 1	4.5	2.7	2.7	0.27	0.054
< 0.625	7.5	< 0.625	7.5	4.5	4.5	0.45	0.09
Controlled mass rate (lb/Dt) =				60	2.712	0.41946	
Device efficiency =				0.00%	95.48%	84.53%	
Cumulative efficiency =					95.48%	99.30%	

Overall Efficiency = 99.30%

Overall Emission Factor = 0.4195 lb PM10/Dt

Permit Limit = 0.434 lb PM10/Dt (equivalent to permit limit of 1.90 lb/hr, 4.375 Dt/hr feedrate)

Lead

Size Range (μm)	Dry ESP (%)	Venturi Scrubber (%)	Wet ESP - Medium Efficiency (%)	Uncontrolled Mass = (from 1997 sewage sludge sampling, assumed distributed over PM10 range)	0.276 lb/Dt
6.0-10	0	99	97		
2.5-6	0	95	90		
0-2.5	0	90	80		

Particle size (μm)	Mass % < (%)	Size range (μm)	Mass % in range (%)	Uncontrolled (lb/Dt)	Dry ESP exit (lb/Dt)	Venturi exit (lb/Dt)	Wet ESP exit (lb/Dt)
10	100	5 - 10	47	1.30E-01	1.30E-01	1.30E-03	3.89E-05
5	53	2.5 - 5	25	6.90E-02	6.90E-02	3.45E-03	3.45E-04
2.5	28	1 - 2.5	16	4.42E-02	4.42E-02	4.42E-03	8.83E-04
1	12	0.625 - 1	4.5	1.24E-02	1.24E-02	1.24E-03	2.48E-04
< 0.625	7.5	< 0.625	7.5	2.07E-02	2.07E-02	2.07E-03	4.14E-04
Controlled mass rate (lb/Dt) =				2.76E-01	1.25E-02	1.93E-03	
Device efficiency =				0.00%	95.48%	84.53%	
Cumulative efficiency =					95.48%	99.30%	

Overall Efficiency = 99.30%

Overall Emission Factor = 0.0019 lb Pb/Dt

Permit Limit = 0.0119 lb Pb/Dt (from permit)

Note: Size distribution taken from Fifth Edition AP-42, Section 2.2, "Sewage Sludge Incineration", Table 2.2-10.
Control efficiencies taken from Fifth Edition AP-42, Appendix B-2, "Generalized Particle Size Distributions", Table B.2-3.